User's Guide

322 HPLC Pump

GILSON®

TABLE OF CONTENTS

TABLE OF CONTENTS

SAFETY

IN THIS CHAPTER

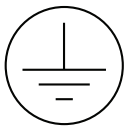
The instrument is intended to be used in a laboratory by trained technical personnel. For safe and correct use, both operating and service personnel should follow the instructions contained in this guide when installing, cleaning, and maintaining the instrument.

The following safety precautions must be observed during all phases of operation, service, and repair of the instrument. Failure to comply with these precautions or with specific warnings elsewhere in the user's guide violates safety standards of design, manufacture, and intended use of the instrument. Gilson assumes no liability for the customer's failure to comply with these requirements.

The instrument has been certified to safety standards required in Canada, Europe, and the United States. Refer to the rear panel label on the instrument or the Declaration of Conformity document for the current standards to which the instrument has been found compliant.

Electronic and Hazard Symbols

The following electronic and hazard symbols may appear on the instrument:

Symbol	Explanation
~	Alternating current
⎓	Direct current
	Protective conductor terminal
|	Electrical power ON
O	Electrical power OFF
	Caution, risk of electric shock
	Caution
	Fuse

Safety Notices

The following safety notices may appear in this document:

⚠WARNING	**WARNING indicates a potentially hazardous situation which, if not avoided, may result in serious injury**
⚠CAUTION	**CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury**
NOTICE	**NOTICE indicates a potentially hazardous situation which, if not avoided, may result in equipment damage**

Lifting

The instrument exceeds the weight one person can lift safely. Two or more people are required to lift the instrument safely. Refer to the Technical Specifications for the weight. Always lift the instrument from the base and follow any unpacking instructions provided with the instrument.

Voltage

Access to the rear panel is necessary. The instrument must be detached from all voltage sources before service, repair, or exchange of parts. For normal operation, the instrument is to be grounded through the AC line cord and power supply provided. Failure to do so can result in a potential shock hazard that could result in serious personal injury.

Use only fuses with the rated current and of the specified type as listed on the rear panel label on the instrument. The instrument must only be operated with the voltage specified on the rear panel label of the instrument and with the grounded AC line cord and power supply provided.

Solvents

Observe safe laboratory practices when handling solvents. If working with hazardous solvents or flammable liquids, ensure that there is proper ventilation and that adequate protection such as safety glasses, gloves, and protective clothing are used.

If dangerous liquids are used, precautions should be taken to limit potential hazards from leaks and/or spillage through the use of a non-flammable tray or use of a fume hood, etc.

If there is the potential of explosive gases being developed, a fume hood or other means should be used to safely manage that risk.

Refer to the Material Safety Data Sheets for the solvents before use.

Replacement Parts

Be sure to use only replacement parts mentioned in the user's guide. Do not repair the instrument or change parts not listed in the user's guide. If it is necessary to replace parts not listed, please contact your local Gilson representative.

Chapter 1

INTRODUCTION

IN THIS CHAPTER

Description

The 322 HPLC Pump is a multi-solvent pump for analytical to semi-preparative high performance liquid chromatography (HPLC). It accommodates flow rates from 0.15 mL/min up to 30 mL/min at pressures up to 8700 psi (600 bar). It includes a built-in, high-pressure adjustable volume dynamic mixer (AVDM) allowing users to perform a binary gradient with a single unit. The 322 Pump is controlled by TRILUTION® LC Software as part of an HPLC system.

Figure 1
322 HPLC Pump

Hydraulic Components

The hydraulics are revealed by opening the removable door. The pre-mounted, principal hydraulic components are pump heads, pressure module, dynamic mixer, purge valve, and outlet filter. Two reciprocating pump motors are contained within the body of the pump. The tops of the pump motors protrude through the front panel. There is a drip tray at the bottom of the pump (see **Drip Tray on page 22**). Solvent bottles can be placed in the tray on the top of the pump (see **Solvent Bottle Tray on page 23**).

The right-hand motor pumps a solvent (normally 'A') via the pressure module to the dynamic mixer and the left-hand motor pumps another solvent (normally 'B') directly to the dynamic mixer.

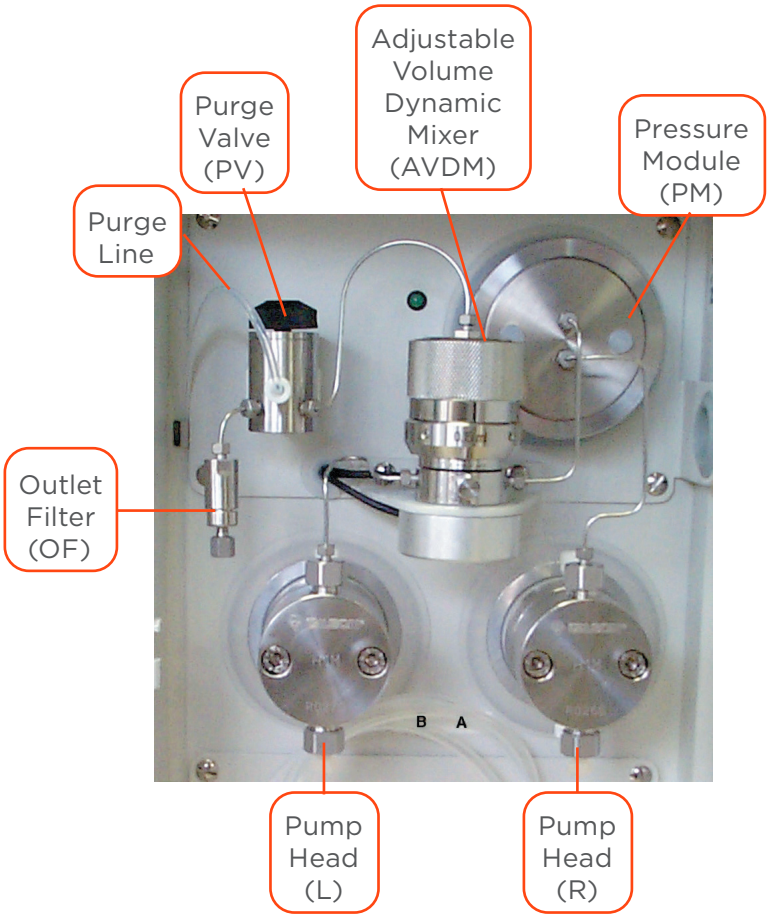


Figure 2
Hydraulic Components

PUMP HEADS

Two interchangeable pump head types are available:

- H1: flow rate from 0.15 to 15 mL/min, pressure up to 600 bar (8700 psi)
- H2: flow rate from 0.30 to 30 mL/min, pressure up to 300 bar (4350 psi)

Each pump head has a solvent inlet port, a solvent outlet port, an inlet port to the rinsing chamber, an outlet port from the rinsing chamber, and a reciprocating piston.

The piston seal and the bellows are inside the pump head. The solvent inlet port and the solvent outlet port are fitted with connectors containing the check valves. All of these items can be serviced by the user.

The pump heads are pre-mounted directly onto the tops of the driving mechanisms, which have the same axis as the piston motors, so pump heads may be changed with relative ease. The pump heads must be dismounted for routine servicing purposes (for example, changing a piston seal).

Figure 3
H2 Pump Head

ADJUSTABLE VOLUME DYNAMIC MIXER (AVDM)

The adjustable volume dynamic mixer (AVDM) performs high-pressure mixing of the solvents coming from channels A and B, and (optionally) solvent coming from another pump or pumps. The dynamic mixer volume is continuously adjustable between 0.20 mL and 2.20 mL. When the dynamic mixer is operating, the indicator (green LED) lights up.

Figure 4
AVDM

PRESSURE MODULE (TRANSDUCER)

The pressure module (transducer) integrates:

- a dampener that minimizes the pulsations created by the reciprocating action of the pump motor.
- a built-in transducer that detects the pressure in this part of the hydraulic circuit.

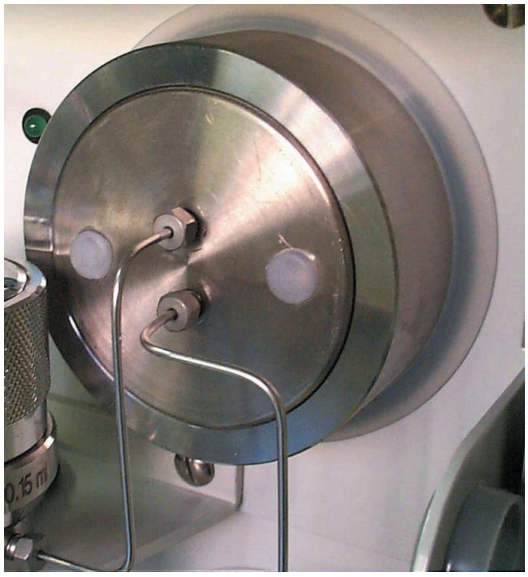


Figure 5
Pressure Module (Transducer)

PURGE VALVE

After mixing, the next component in the hydraulic circuit is the purge valve, which is used to manually direct the mobile phase towards the outlet filter or divert to the drain.

OUTLET FILTER

The outlet filter protects the injection valve and the column. The outlet filter can be replaced by the user.

Figure 6
Purge Valve and Outlet Filter

Front Panel

The 322 Pump must be controlled by external software, such as TRILUTION LC. The 322 Pump has a front panel to control power or indicate errors.

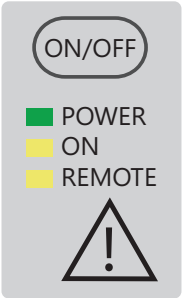


Figure 7
322 HPLC Pump Standby Panel

Rear Panel

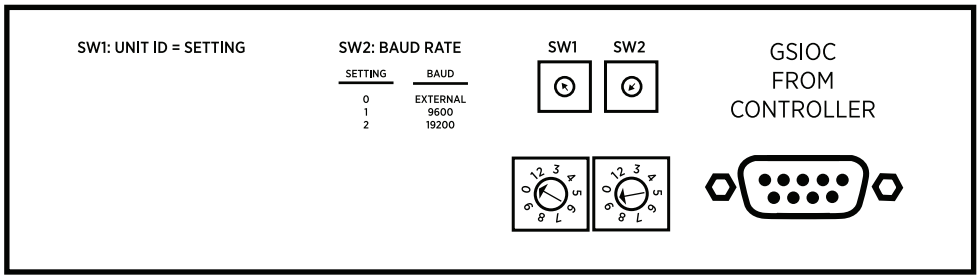


Figure 8
322 HPLC Pump Rear Panel Diagram

All electrical connections are made on the rear panel. The rear panel of the 322 Pump houses the main power switch, a GSIOC port, unit ID selector, and baud rate selector.

The pump has two ON/OFF switches: one on the power receptacle on the rear panel and the other on the front panel above the LEDs.

Figure 9
ON/OFF Switches on Rear Panel

Unpacking

The pump is delivered with most major components already assembled. Keep the original container and packing assembly so the unit may be shipped safely, if necessary.

Carefully unpack the pump and its accessories from the carton.

⚠CAUTION

Because of its weight, you should take special care when handling the large carton. Pump modules are heavy and should be lifted from the carton with care, by two people. Instructions describing the unpacking procedures can be found on and in the carton.

It is necessary for two people to lift the 322 Pump out of the box, using the straps provided. The 322 Pump weighs approximately 26 kg (57 lbs.). To avoid personal injury and for general safety, if moving or lifting the system, always get another person to assist you. Always follow local health and safety regulations.

Standard Equipment

After the instrument and the accessories have been unpacked, you should have the following:

- 322 HPLC Pump with H1 or H2 Pump Heads
- An accessory kit that includes:
  - Glass Priming Syringe
  - Solvent Bottle Tray
  - GSIOC Cable
  - Wrenches
  - Glass Bottle
  - Tubing and Fittings
  - Bellows Mounting Tool
  - Extra Fuses
  - Power Cord
  - Plumbing Kit for Piston Rinsing Chambers

DOCUMENTATION

Documents are provided on the supplied *322 HPLC Pump Documentation USB*.

Optional Accessories

- Column Holder
- Manual Injection Valve Holder

For part numbers and installation instructions for the optional accessories, refer to the dedicated appendices.

Technical Specifications

Please be aware of the following before operating the pump.

NOTICE **Changes or modifications to the pump not expressly approved by Gilson could void the warranty.**

This instrument complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This instrument may not cause harmful interference, and (2) this instrument must accept any interference received, including interference that may cause undesired operation.

Shielded cables must be used with the pump to ensure compliance with the FCC Class A limits.

322 HPLC Pump

Specification	Description
Pump Type	Binary Gradient Pump
Hydraulic System	Reciprocating Piston Pump
Pump Head	H1: Up to 15 mL/min H2: Up to 30 mL/min
Flow Rate	**Range - Single Head** H1: 0.015–15 mL/min H2 : 0.030–30 mL/min **Range (Recommended) - Two Heads** H1: 0.15–15 mL/min H2 : 0.30–30 mL/min **Increment** 0.001 mL/min
Flow Accuracy	± 2%
Flow Precision	≤ 0.7% RSD
Gradient	**Solvents** Two **Formation** High Pressure Mixing with Adjustable Volume Dynamic Mixer (AVDM) **Composition Increment** 0.1%
Gradient Accuracy	± 2%
Gradient Precision	≤ 0.7% RSD
Operating Pressure	H1: 5–600 bar (70–8700 psi) H2: 5–300 bar (70–4350 psi)

TECHNICAL SPECIFICATIONS CONTINUED ON PAGE 18

322 HPLC Pump

Specification	Description
Compressibility Compensation	Settable Compensation Range 0–2000 Mbar[-1]
Piston Seal Wash	Pump Head Inlet and Outlet Ports to/from a Rinsing Chamber
Priming	Manual with Built-in Prime/Purge Valve via Control Software or Syringe
Liquid Contact Materials	316L Stainless Steel, Sapphire, Ceramic, HDPE, PTFE, Ruby, Titanium, FEP, PCTFE, PEEK, ETFE For more information, refer to Liquid Contact Materials on page 59.
Control and Communication	**Communication** GSIOC (Gilson Serial Input Output Channel) **Software Control** TRILUTION® LC Software
Electrical	**Line Voltage** 90–260 VAC **Frequency** 50 or 60 Hz **Power Consumption** 150 W
Environmental	**Operating Temperature** 4°C to 40°C **Operating Humidity** 15%–80% **Operating Altitude** Up to 2000 m (81 kPa or 604 mmHg)
Physical	**Dimensions (W x D x H)** 26 x 45.7 x 30.3 cm (10.2 x 18 x 11.9 in.) **Weight** 25.9 kg (57 lbs.) Shipping Weight: 30.4 kg (67 lbs.)
Contact **techsupport@gilson.com** for the methods and conditions that were used to obtain technical specifications.	

Customer Service

Gilson, Inc. and its worldwide network of representatives provide customers with the following types of assistance: sales, technical support, applications, and instrument repair.

If you need assistance, please contact your local Gilson representative. Specific contact information can be found at **www.gilson.com**. To help us serve you quickly and efficiently, please refer to Repair and Return Policies on page 49.

Chapter 2

INSTALLATION

IN THIS CHAPTER

This chapter describes the minimum connections required for operation (including procedures for preparing piston rinse lines). The pump must be set up and installed in the order described in this chapter to avoid damaging the system.

TRILUTION® LC Software is the recommended controller for the pump.

The pump is delivered with the main hydraulic components installed. Solvent bottles can be placed in the removable trays atop the pump, on the bench, or on the floor.

Electrical Connections

Plug the power cords into the pump and all associated devices before making the communication or hydraulic connections. Power is needed to prime the pump and piston rinse chambers prior to use.

Rear Panel

All electrical connections are made on the rear panel. Also present on the rear panel are the fan's ventilation slots, which must never be obstructed in any way.

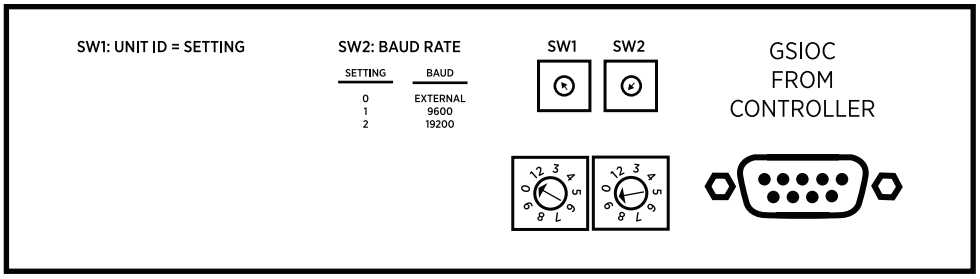


Figure 10
322 HPLC Pump Rear Panel Diagram

GSIOC ID

The GSIOC ID may be changed when the pump is being controlled from a computer. The configured ID on the pump must correspond to that set in the controlling software.

The GSIOC identification number (ID) that you set must be unique for each item of Gilson equipment.

The GSIOC ID (0–9) is set mechanically for the 322 Pump using the SW1 (left) selector on the rear panel.

Figure 11
GSIOC ID
(0–9)

BAUD RATE

The baud rate (9600, 19200, or External) is set mechanically using the SW2 (right) selector on the rear panel.

External clock control should be selected for the 322 Pump running under computer control. Internal is used when the connected device does not provide a clock source, in which case you have to select an appropriate baud rate.

Figure 12
Baud Rate
0 = External
1 = 9600 Baud
2 = 19200 Baud

VOLTAGE SELECTION

The pump can be connected to an AC power supply of 110/120V or 220/240V. Automatic selection of the operating voltage takes place on the power supply board.

POWER CONNECTION

Plug the power supply cord that you received with the pump into the socket on the power receptacle (standard 3-pin connector) and to a suitable source of power.

Cabling for TRILUTION LC Control

Plug one end of a GSIOC cable into the port marked GSIOC FROM CONTROLLER. Plug the other end into the GSIOC port of an interface module (or other controlling device, such as a Gilson liquid handler), and then connect an RS-232 cable from the interface module (or other controlling device) to the computer.

Hydraulic Connections

Pump Heads

Two pump heads are available (H1 and H2) and are installed on the pump prior to shipment. For routine servicing, or to fit a different pump head, refer to **Pump Head on page 33.**

Solvent Inlet Lines

The standard accessory package contains inlet lines, marked A and B, each fitted with a 20 µm inlet filter.

Air entering the hydraulic circuit would adversely affect the flow rate. Make sure that all connectors are correctly seated and properly tightened.

To ensure the connectors are seated and properly tightened:

1. Remove the plastic plug from the inlet of each head.
2. Check that the reverse ferrule is correctly seated at the end of the tubing.
3. Connect line A to the right head and line B to the left head.

NOTICE	**When screwing or unscrewing the white connector, secure the tubing with one hand and slide the connector down. Make sure the ferrule touches the female port while sliding the connector down to prevent the line from twisting.**

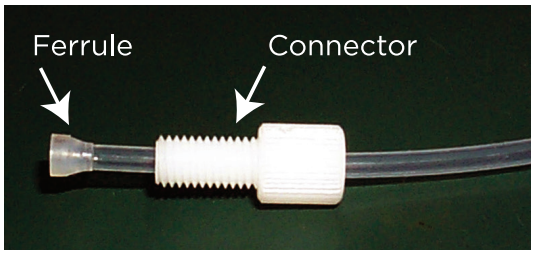


Figure 13
Ferrule and Connector Close Up

4. Check that the connectors are tight enough to prevent air from entering the hydraulic lines.
5. Thread the solvent line through the port on the door before placing the inlet filter in the appropriate solvent bottle.

6. Clip the solvent lines to the tray. Push the tubing into the fissure on the clip before placing it in the appropriate slot on the tray.

> **NOTE** Because of the larger diameter tubing, a different clip is supplied for the rinsing line.

7. Prime the solvent lines prior to operation. Follow the instructions provided in Priming on page 26 for both TRILUTION LC and manual control.

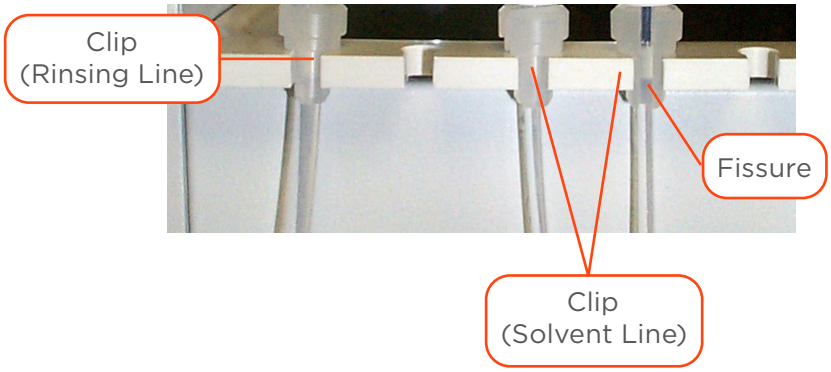


Figure 14
Hydraulic Connections in Solvent Tray

Drip Tray

A removable drip tray fitted to the pump is supplied.

The drip tray slots into the well at the bottom of the pump. Installation consists of lifting up the tray, fitting one end with a length of tubing. The other end of the tubing goes to the drain (or a suitable receptacle) via the drain tubing exit port. Installation is completed by replacing the drip tray.

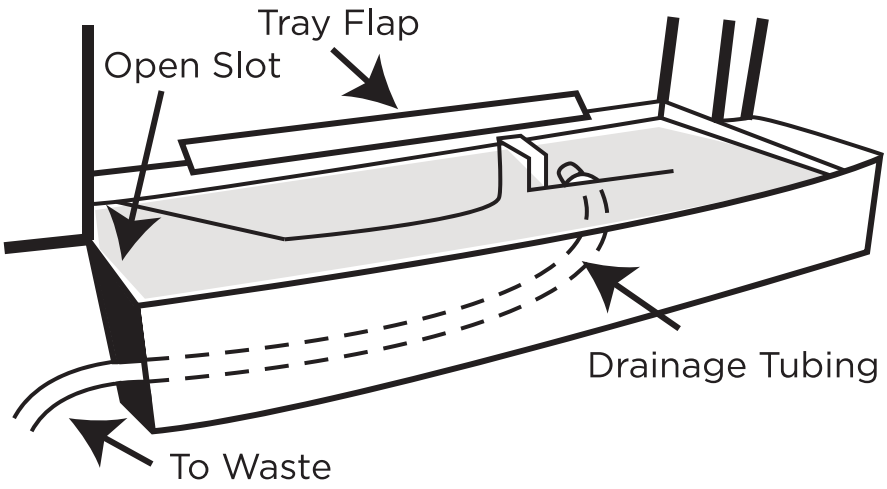


Figure 15
Drip Tray Diagram

Solvent Bottle Tray

The solvent bottle tray sits on top of the pump with its feet resting in the special recesses.

Figure 16
Solvent Bottle Tray

Piston Rinsing Chamber

When a pump is delivered, the inlet and outlet ports to the rinsing chamber are fitted with plugs, which prevent airborne particles from entering the ports. If you do not need to use piston rinsing, you should leave these plugs in place.

It is easier to make the hydraulic connections to the rinsing chamber when you first remove the drip tray. (Don't forget to put it back before starting the purge.)

If the solvent is an aqueous solution containing more than 0.1 M of solute, which is solid in ambient conditions, then the piston should be rinsed continuously with water.

A plumbing kit must be installed for the piston rinsing chamber of either head. To facilitate the required connections for the rinsing liquid(s), a plumbing kit (part number 380132254) is supplied as a standard accessory, and is usually installed on the right head. An additional kit may be ordered for installation on the left head if required.

For details about installing the piston rinse plumbing and the piston rinsing procedure, refer to **Piston Rinsing Procedure on page 28.**

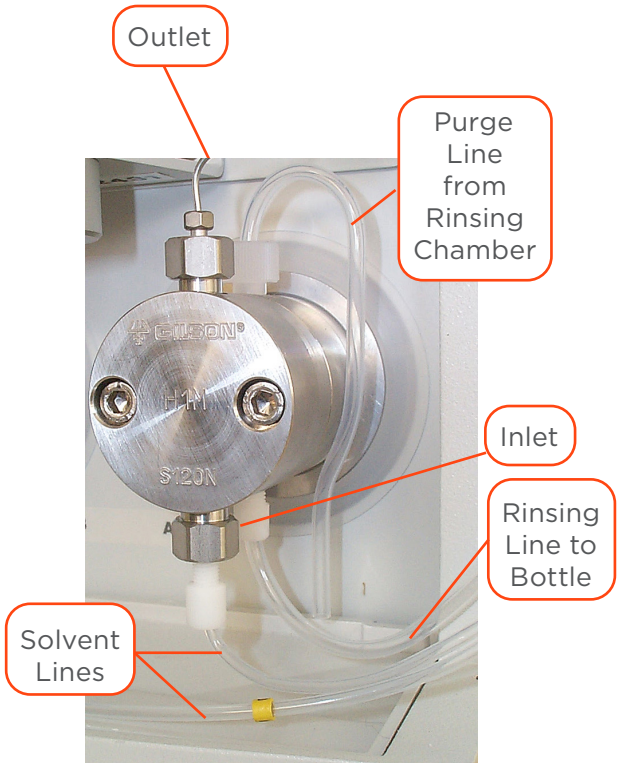


Figure 17
Piston Rinsing Chamber

Adjustable Volume Dynamic Mixer (AVDM)

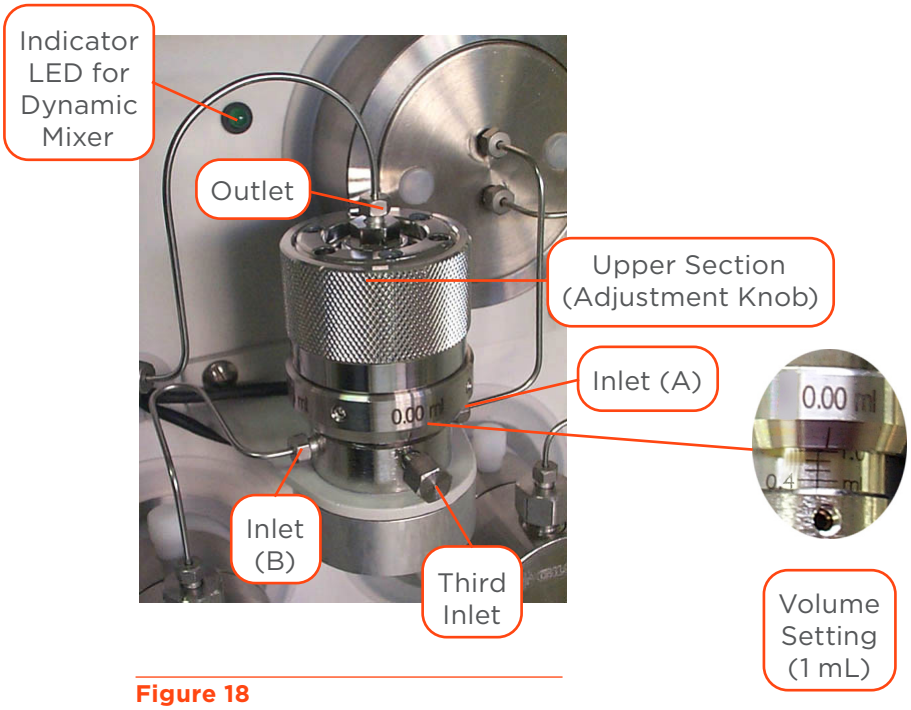


Figure 18
Adjusting the Mixer Volume

ADJUSTING THE MIXER VOLUME

The adjustable volume dynamic mixer (AVDM) is factory set at 0.40 mL (default value). You can set a value from 0.20 to 2.20 mL (refer to the table). To change the mixer volume, fully depressurize the pump by opening the purge valve, and then turn the adjustment knob to the desired volume. For fast composition gradients, use the minimum value (0.20 mL). For perfectly homogeneous mixtures, as required (for example) in trace analysis using an isocratic mobile phase with low wavelength detection, you may have to set a value higher than indicated in the table, which shows typical values.

Settings are realized (mechanically) by rotating the adjustment knob; graduated markings on the body indicate the volume setting. There are four vertical graduations on the upper section at 0.05 mL intervals, corresponding to 0.00, 0.05, 0.10, and 0.15 mL. There are eleven horizontal graduations on the body at 0.20 mL intervals; one complete turn on the adjustment ring equals 0.20 mL.

Typical Mixer Volume by Flow Rate

Flow Rate (mL/min)	Mixer Volume (mL)
0.15–0.6	0.2–0.3
0.7–2	0.4–1.0
2.1–5	1.1–2.2
>5	2.2

⚠CAUTION **When the dynamic mixer is operating the indicator (green LED) lights up. The AVDM may only be adjusted when the pump is stopped and depressurized.**

Chapter 3

OPERATION

IN THIS CHAPTER

TRILUTION® LC Software provides software control of the pump for setup and operation. Refer to the *TRILUTION® LC Software User's Guide* for more information.

Front Panel and Startup

The pump has two ON/OFF switches: one on the power receptacle on the rear panel and the other on the front panel above the LEDs.

Figure 19
Indicator Lights

Powering the Pump On

1. Press the switch on the power receptacle to the 'I' position; the 'Power' LED (green) on the front panel should light up; if it does not, check the fuses and power connections.
2. Press the ON/OFF button on the front panel; the ON indicator light should illuminate.

Priming

Priming helps prevent the introduction of air bubbles into the system. It is recommended to prime the pump before using it for the first time, or if it has not been used for some time.

This is an essential step, which must be carried out before operating the pump.

NOTICE	**Operating the pump dry, even for a short time, can damage the equipment. Use the syringe supplied with the pump head to prime the pump if the pump does not self-prime within two minutes.**

NOTE	**Ensure that all plumbing connections have been made as described in INSTALLATION.**

Priming the Pump

1. Fill the solvent bottle(s) with degassed, high performance liquid chromatography (HPLC) grade solvent(s) and immerse the filter connected to the inlet tubing for each pump into the solvent.
2. Open the purge valve by turning the black knob fully counterclockwise to direct the flow to the atmospheric purge-outlet. Make sure the purge line is connected to the purge valve and directed to an appropriate waste receptacle.
3. Use the controlling software to run the pump at the maximum flow rate for the pump head. If self priming is achieved, skip to step 9. If the pump does not self-prime within two minutes, stop the pump and continue with manual priming.
4. Disconnect the waste tubing from the purge valve and then connect the priming syringe (part number 36460058) equipped with fitting adapter (part number 495018).
5. Draw liquid into the syringe. It is likely that it will first draw air, but then liquid droplets should start to appear.
6. Disconnect the syringe from the waste outlet.
7. Reconnect the waste tubing to the purge valve and place the other end in a waste container.
8. Run the pump to dispense at a suitable flow rate.
9. When no bubbles can be seen at the waste tubing, stop the pump to end the priming procedure.
10. Turn the knob on the purge valve all the way to the right (clockwise) to close the outlet to waste.

Depending on your solvents, ensure that the rinse plumbing kit is installed. Refer to **Piston Rinsing Procedure on page 28.**

Priming Using TRILUTION LC Control

1. Fill the solvent bottle(s) with degassed, high performance liquid chromatography (HPLC) grade solvent(s) and immerse the filter connected to the inlet tubing for each pump into the solvent.
2. Open the purge valve by turning the black knob fully counterclockwise to direct the flow to the atmospheric purge-outlet. Make sure the purge line is connected to the purge valve and directed to an appropriate waste receptacle.
3. Open a method in TRILUTION LC that includes the pump in its configuration.
4. Select **Run**.
5. Select the **Manual Control** icon. The **Manual Control** window appears.

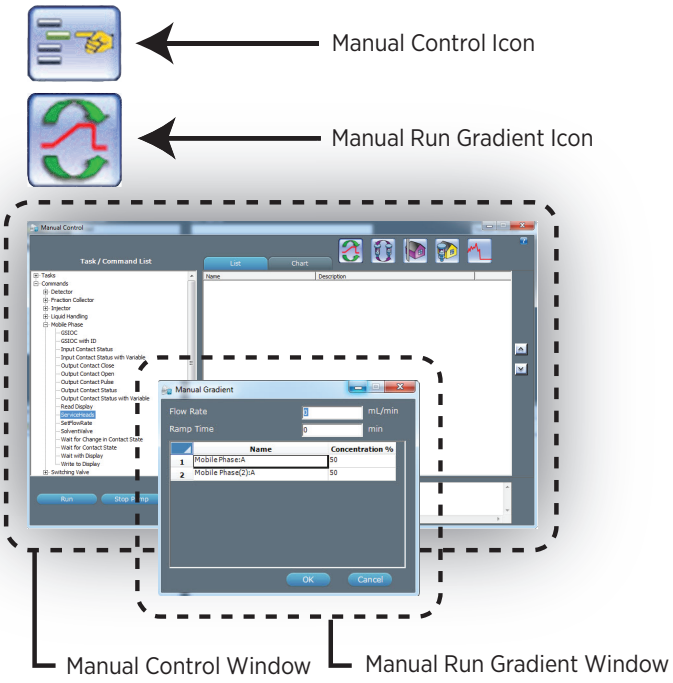


Figure 20
Priming with TRILUTION® LC Software

6. Select the **Manual Run Gradient** icon. The **Manual Run Gradient** window appears.
7. Enter a flow rate (maximum flow rate for the pump head, for example) into the **Flow Rate** field.
8. Set the **Concentration%** for the first mobile phase instrument to **100**. Values for any additional mobile phase instruments automatically set to 0.
9. Select **OK** to confirm. Allow the solvent to flow through the purge line until there are no air bubbles present.
10. Repeat steps 5–9 for any additional mobile phase instruments. This will ensure that each pump head is primed individually.
11. Stop the pump by selecting **Stop Pump** on the **Manual Control** window.
12. Close the purge valve.

Piston Rinsing Procedure

PLUMBING SETUP

1. Fill the glass bottle (part number 54350403) with distilled water and push the open end of each rinsing line through the bottle's pierced cap, to between 1 to 2 cm of the bottom.
2. Clip the rinsing lines to the tray (the longer line connects to the left head). Each line is first attached to a clip by pushing it gently into the fissure, and then the clip is pushed into a slot on the tray.
3. Connect the rinsing line to the rinsing chamber inlet at the bottom of the head.
4. Connect the shaped purge line to the rinsing chamber outlet at the top of the head.

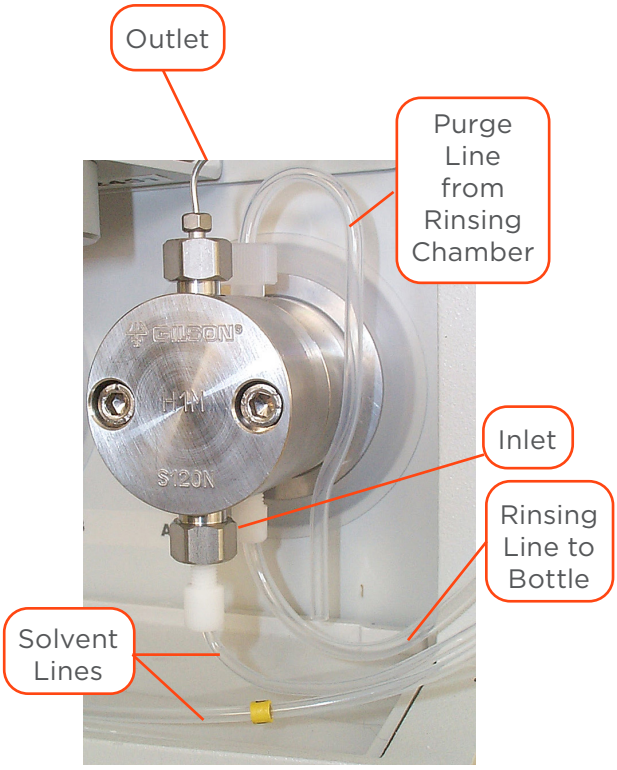


Figure 21
Piston Rinsing Chamber

PRIMING OPERATION

1. Ensure that each purge line is closed (turn each connector fully counterclockwise until finger tight), and then pump at an appropriate flow rate—the maximum flow rate, for example. After about 20 seconds, water should have sufficiently filled the rinsing line, even though some air is also present.
2. Stop the pump and then undo both purge line connectors. Water will run from each purge line into the drip tray; the rinsing lines and rinsing chambers will fill with water. When you see bubble-free water in the rinsing lines, and that air is no longer exiting from the head via the purge lines, close both purge lines. In use, water from the small bottle rinses the piston and although it is a closed circuit, you may need to change the water from time to time and also repeat this procedure.

NOTE **To get the initial flow of water to reach the pump head, it may be necessary to use a priming syringe (part number 36460058) to pull excess air from the rinse line. Opening and closing the purge line connectors can also encourage initial rinse water flow.**

NOTICE **Over time the buffer concentrate will dilute into the water bottle via entropy and laminar flow. To prevent sediment build-up in the piston chamber, change the water and clean the bottle.**

Pump Operating Parameters

Refill Time

Refill time is the duration of the piston return stroke.

The refill time can be adjusted from 125–1000 ms.

Normally, you can use the default value of 125 ms. If cavitation occurs, then use a higher value.

For volatile and non-degassed solvents, better performance may be achieved by entering a higher value, up to the limits shown.

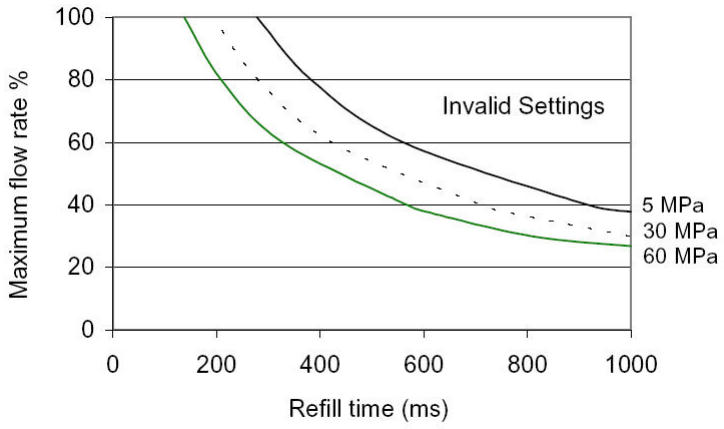


Figure 22
Refill Time

Inlet Pressure

Inlet pressure is the pressure at the inlet to the pump head.

The inlet pressure can be adjusted from 0–50 MPa.

Compressibility

Compressibility is a compensation parameter for solvent compressibility.

The compressibility can be adjusted from 0–2000 $Mbar^{-1}$. The standard compressibility values are 34 for water, 162 for methanol, and 180 for acetonitrile.

Chapter 4

MAINTENANCE

IN THIS CHAPTER

To obtain optimum performance and maximum life from the pump, it is important to keep the instrument well-maintained.

User maintenance is generally limited to the following:

- Cleaning check valves and filters (clean outlet filter after changing piston seal)
- Replacing parts subject to wear and tear in each pump head: piston seal, check valves, and piston assembly
- Run-in the pump head and/or seal

Maintenance Overview

General guidelines for the periodic replacement of the 'wear parts' are indicated in the table below, according to the amount of use: intensive, regular, or occasional. This schedule should be regarded as a guide; changes in performance, or visible leaks, give an indication that a part should be changed.

Component	Intensive (168 h/week)	Regular (40 h/week)	Occasional (10 h/week)
Piston seals	4.5 months (3000 h)	1–1.5 years (2500 h)	2 years (1000 h)
Check valves	7 months (4500 h)	1.5 years (3000 h)	3 years (1500 h)
Piston assembly	9 months (6000 h)	2–3 years (5000 h)	4 years (2000 h)

NOTE **These recommendations are based on the assumption that the pump is working at half its maximum flow rate and pressure.**

⚠CAUTION **To prevent injury, observe good laboratory practices when handling solvents. Know the physical and chemical properties. Refer to the Material Safety Data Sheets for the solvents used.**

Cleaning

Keep the pump clean for peak performance. Always turn the power off to the pump before cleaning. Wipe the pump with a soft cloth dampened with a mild detergent and disinfect as needed.

Pump Head

NOTICE

Before the pump head can be physically removed from the pump, you must disengage the pump head from the pump motor using the dismount procedure.

Removal of the pump head is required for all maintenance described in this chapter. Refer to the instructions in this section when removing or installing the pump head.

Do not autoclave the pump head.

Dismount Pump Heads

DISMOUNTING WITH TRILUTION LC

1. Open a method that includes the pump in its configuration.
2. Select **Run**. The **Application Run** window will appear.
3. Select the method name from the **Method Configuration** drop-down box.
4. Select the **Method Configuration** icon.
5. Select the **Manual Control** icon. The **Manual Control** window will appear.
6. Click **'+'** next to the **Commands** field to expand the list, and then again next to **Mobile Phase**.
7. Drag and then drop the **ServiceHeads** command into the **List** space. The **ServiceHeads Properties** window appears.
8. Change the **MountHeads** value to **False**.
9. Select **OK** and then select **Run**.
10. Wait for the pistons to fully retract.

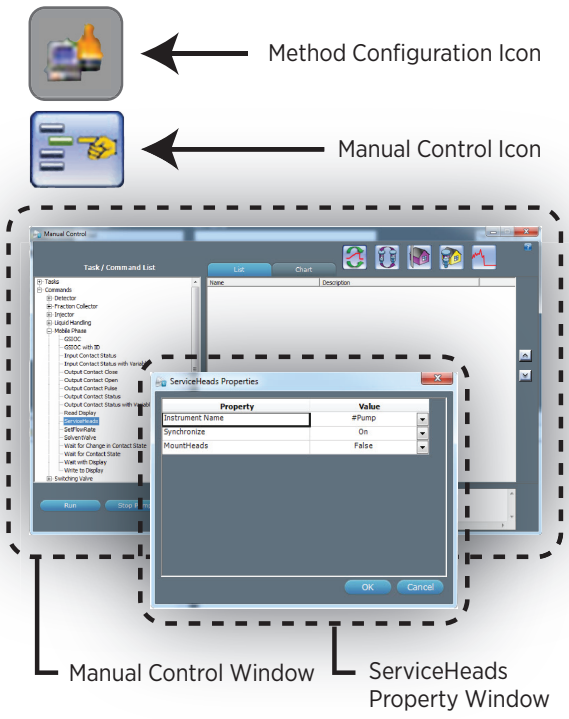


Figure 20
Manual Control Windows and Icon

NOTE

Repeat steps 1-10 to mount the pump heads, but select TRUE for the MountHeads property in the ServiceHeads command.

MANUAL DISMOUNTING PROCEDURE

1. Open the purge valve by turning the black knob counterclockwise.
2. Switch off the pump and disconnect it from the power supply.
3. Remove the lower rear panel by removing the retaining screws. The mounting screws for both heads are now visible.
4. Use a 3 mm Allen wrench to turn the mounting screw in the clockwise direction, until you reach a stop (you will hear a 'thump' as you hit the stop). At this point, the piston engaging mechanism will be withdrawn to a maximum distance into the interior of the pump motor. Turn the wrench two turns counterclockwise.

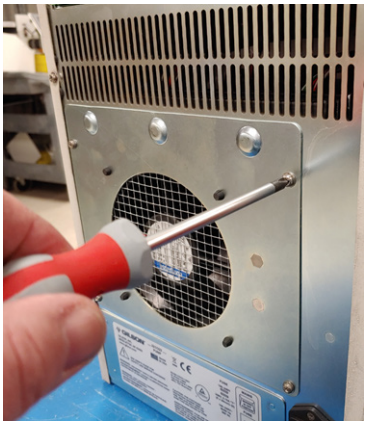


Figure 21
Removing the Lower Rear Panel

Figure 22
Loosening Mounting Screws

Remove Pump Head

1. Disconnect all solvent lines from the pump head.
2. Remove the two screws securing the pump head with the supplied 5 mm Allen wrench. Support the pump head with your other hand while loosening the screws, alternating equally between the two. Moderate force may be required to remove the pump head.

Figure 23
Loosening Pump Head Screws

Disassemble Pump Head

The following steps should be carried out on a clean, dry surface. No special tools are required.

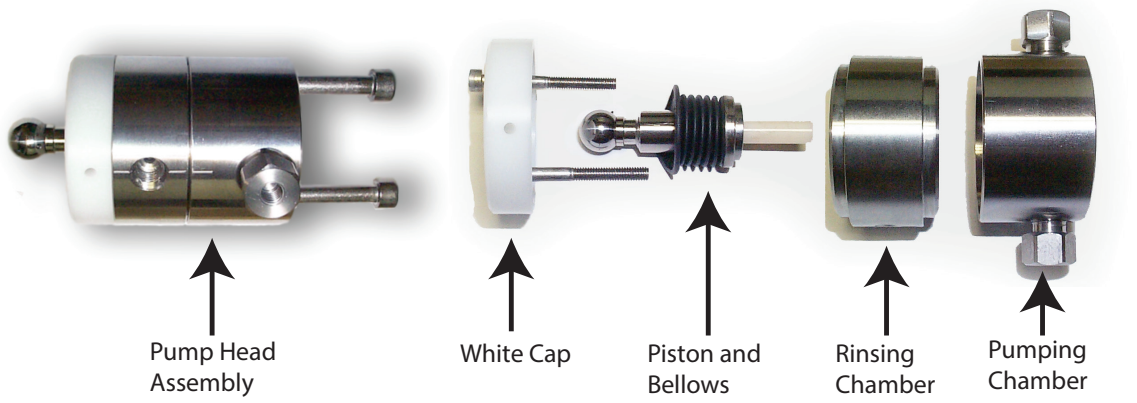


Figure 24
Complete Pump Head Assembly (left) and Disassembled Pump Head (right)

1. Undo the two retaining screws using a 3 mm Allen wrench (part number 4320302).

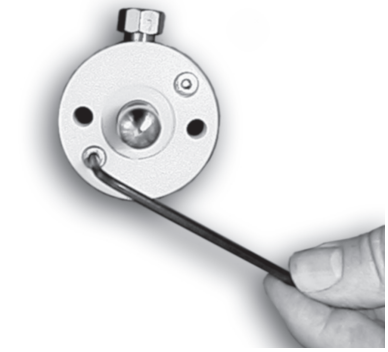


Figure 25
Initial Steps for Pump Head Disassembly

2. Remove the white cap and retaining screws.

Figure 26
Remove the White Cap and Retaining Screws

3. Pull the piston and bellows out of the body of the pump head.

Figure 27
Pull the Piston and Bellows Out of Pump Head

4. Pull apart the two halves of the pump head using a slight twisting motion.

Piston Seals

The nature of the liquid pumped is a major factor affecting longevity of the piston seal. The piston seal consists of a seal ring made of either graphite reinforced PTFE (black) or HDPE (yellow) and a spring made of Hastelloy® C-276 (wire). It must be changed whenever a piston seal leak occurs.

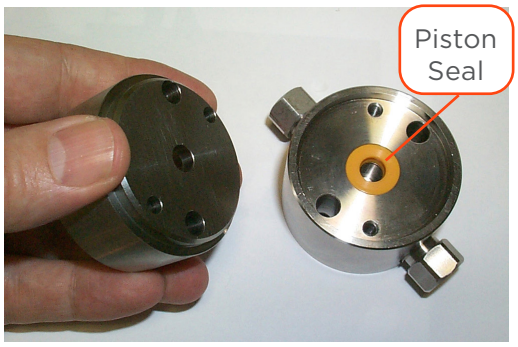


Figure 28
Piston Seal Location

Choose piston seals based on the solvents used:

- The black, polytetrafluoroethylene (PTFE) piston seals are generally best suited for use with organic, low polarity solvents such as tetrahydrofuran, hexane, methylene chloride, and carbon dioxide (part number 38013222 for H1 pump head or part number 38013224 for H2 pump head).
- The yellow HDPE piston seals are generally best suited for use with water, aqueous solvents, alcohols, acetonitrile, and polar solvents. Pump heads are supplied from the factory with the yellow seal (part number 38013220 for H1 pump head or part number 38013223 for H2 pump head).

The piston, bellows, and spacer can also be replaced while the pump head is disassembled.

Replace a Piston Seal

The following steps should be carried out on a clean, dry surface. No special tools are required. These instructions assume that the pump head has been dismounted, removed and disassembled per the instructions in the previous section.

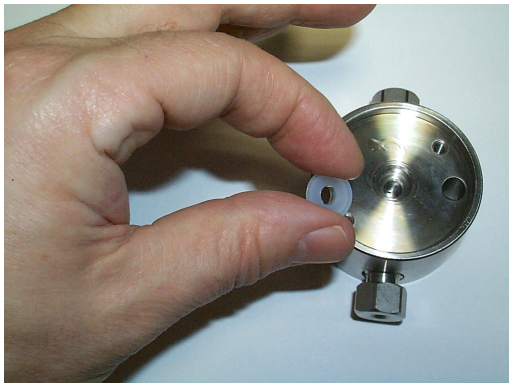


Figure 29
Piston Seal Removal

1. Remove the piston seal either by carefully levering it out with the end of the Allen wrench or blocking the outlet and using an air line, inserted into the center of the seal, to blow the seal out of the recess in the pump head. Discard the seal.
2. Clean out any debris from the seal recess using a soft cloth or an air line.
3. Push a new seal carefully into the recess.
4. Initialize and run-in the new seal(s) as described in **Run-In Procedure on page 45.**

Piston and Bellows

The following steps should be carried out on a clean, dry surface. These instructions assume that the pump head has been dismounted, removed and disassembled per the instructions in the **Pump Head** section in this chapter.

Inspect the bellows for damage. If the piston bellows are cracked, damaged, corroded, or degraded by use, follow these instructions for removal and replacement.

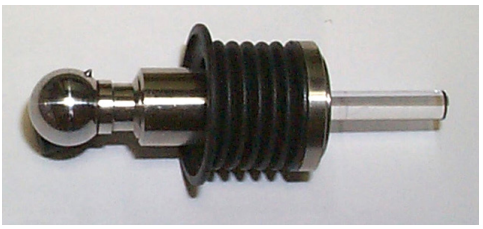


Figure 30
Intact Piston Assembly

NOTE **Although piston shafts vary in size, the procedure for bellows replacement is identical.**

Figure 31
Disassembled Piston Assembly

Remove Bellows

Use your thumbs to remove the bellows; moderate force is required. When removing the bellows, support the piston by the head, not by the shaft.

Figure 32
Removing the Bellows

Figure 33
Individual Components (Piston and Bellows)

Replace Bellows

1. Insert the bellows tool (part number 38013235) into the open end of the bellows. This tool helps ensure that the orifice at the end of the bellows remains open while you work.

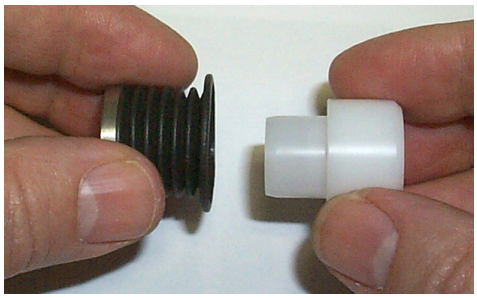


Figure 34
Inserting the Tool

Figure 35
Opening the Orifice

2. Place the tool and bellows on a firm, flat surface.
3. Push down on the metallic ring using four fingers until the orifice grips the end of the tool on its own. The tool, which keeps the end of the bellows open, enables the bellows to be slid back into position.
4. Pull on the metallic ring at the end of the bellows until it can go no further; moderate force is required. When refitting the bellows, support the piston by the head, not by the shaft.

Figure 36
Refitting

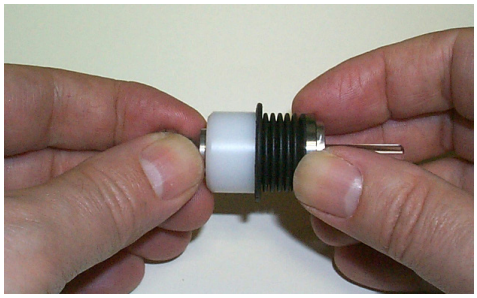


Figure 37
Pull on the Metallic Ring

5. Remove the tool and check that end of the bellows (with the metallic ring) is correctly seated against the piston collar.

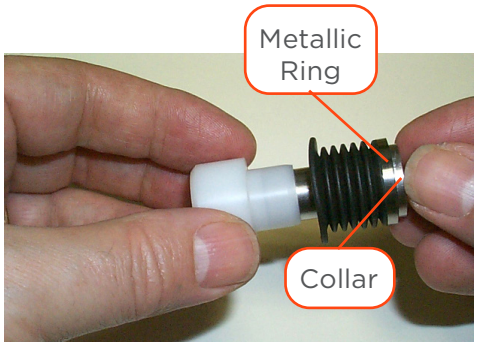


Figure 38
Metallic Ring and Piston Collar Seating

Piston Rinsing Chamber

Change the rinsing liquid at least once a week.

For details, refer to **Piston Rinsing Procedure on page 28.**

Reassemble Pump Head

The following steps should be carried out on a clean, dry surface.

1. Push the two halves of the pump head (rinsing and pumping chambers) together with a slight twisting motion.
2. Turn the rinsing chamber relative to the pumping chamber, until holes for the pump head retaining screws are aligned (because of the asymmetry of the holes there is only one correct position).
3. Check that the marks on the rinsing and pumping chambers are aligned.
4. Refit the bellows to a clean piston and insert the assembly fully into the rinsing chamber.

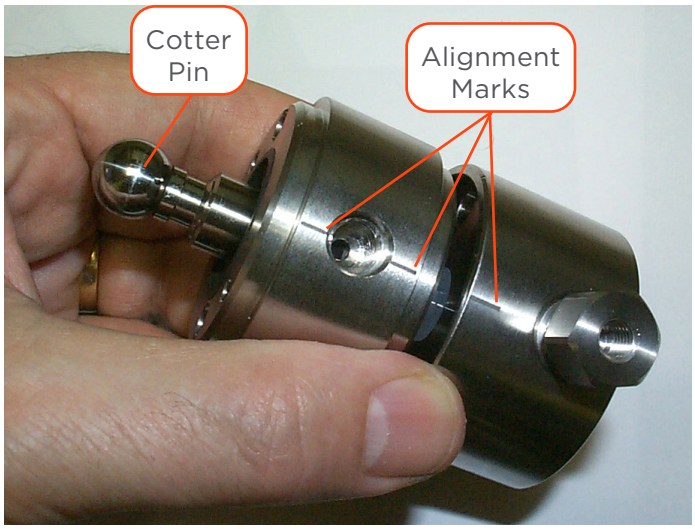


Figure 39
Correct Alignment of Chambers and Pistons

Figure 40
Correctly Seated Piston Assembly

5. Turn the piston until the small cotter-pin at the rounded end of the piston is in line (approximately) with the alignment marks on the pump head.
6. Refit the white cap, reinsert the screws, and progressively tighten them, making sure that the alignment marks are still correctly aligned (do not overtighten the screws).

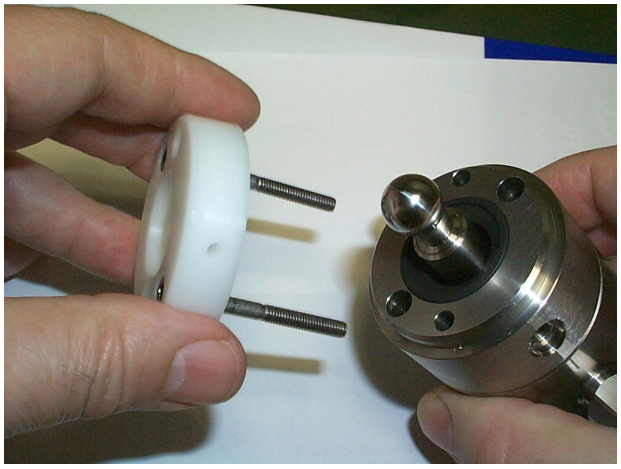


Figure 41
Refitting the White Cap

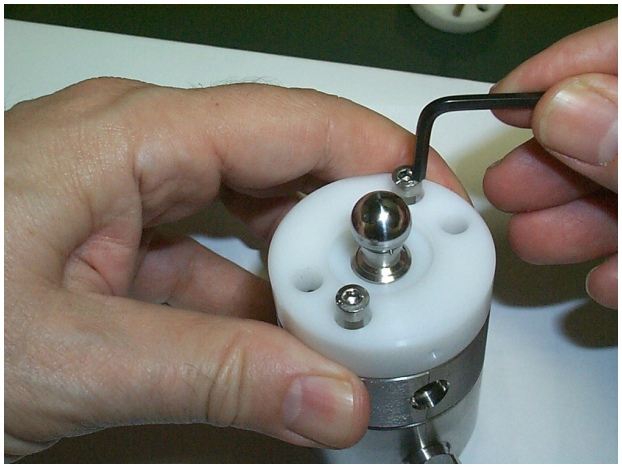


Figure 42
Tightening the Screws

NOTICE **Do not turn the piston after the head is reassembled, because it is possible to damage the bellows.**

Check Valves

The check valves are supplied as cartridges: one for the inlet connector and one for the outlet connector. The two check valves, inlet and outlet, should be cleaned periodically to ensure reliable flow rates. Reliable flow rates will be achieved only if the check valves are kept in good operating condition by proper care and maintenance.

NOTE **Because the dimensions of the threaded parts of the connectors are different, neither the connectors nor the cartridges are interchangeable. This also applies to the check valve cartridges, which have different forms.**

The check valves must not be disassembled into sub-components. No check valve sub-component is available from Gilson.

Cleaning a Check Valve

This procedure is carried out with the check valves installed:

1. Open the purge valve to the drain position. Make sure the purge line is connected and directed to an appropriate waste receptacle.
2. Pump isopropanol (provided the current solvent and isopropanol are miscible).

⚠CAUTION **To prevent injury, observe good laboratory practices when handling solvents. Know the physical and chemical properties. Refer to the Material Safety Data Sheets for the solvents used.**

3. When the pump head is full of isopropanol, stop the flow for at least 15 minutes, to dissolve any sticky deposits.
4. Reconnect the previous solvent and then pump the isopropanol to waste.
5. Check the flow rate. If the flow rate is still low, remove the check valve and then clean the check valve by blowing compressed air though it. If the flow rate is still low, replace the check valve.

Replacing a Check Valve

A check valve can be replaced without dismounting the head; however, the pump must first be powered off and the hydraulic tubing must be disconnected from the pump head.

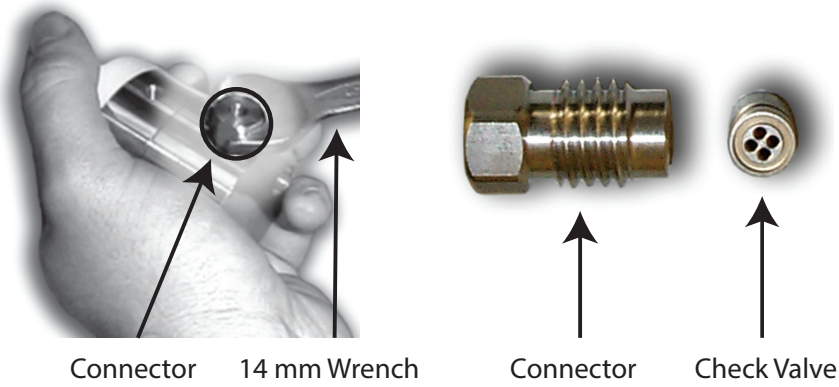


Figure 43
Check Valve Components

1. Loosen the connector with a 14 mm wrench, and then unscrew completely by hand.
2. Remove the check valve from the connector.
3. Make sure that the connector and pump head housing are clean.
4. Slide a new check valve into the connector.

> **NOTE** The arrow on the cartridge must point in direction of solvent flow.

Figure 44
H1 Inlet Check Valve (Left), H2 Inlet Check Valve (Center), and H1/H2 Outlet Check Valve (Right)

5. Screw the connector into the pump head housing.
6. Carefully tighten the connector using a torque wrench set to 7 Nm. Or, turn the connector using the 14 mm wrench until there is contact, then tighten the connector by turning it a further 30° in the clockwise direction. If leakage is observed, tighten the connector progressively until the leakage stops.
7. Run the pump and perform the **Leak Test Procedure on page 45**.

Filters

Inlet Filters

To protect the check valves, an inlet filter must be used with all solvents. Inlet filters must be in good condition for the pump to operate efficiently.

Clean the inlet filter using a suitable solvent. Change the inlet filter if you suspect that it has become plugged.

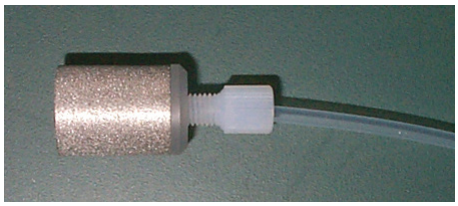


Figure 45
Inlet Filter

Outlet Filter

The outlet filter protects the injection valve and the column. A plugged outlet filter may cause pressure buildup and leaks. Check and clean the interior of the outlet filter routinely and, when necessary, replace the filter cartridge.

For the outlet filter, the normal pressure drop is 1 MPa maximum with 30 mL/min of methanol.

When the pump is new, and also when a piston seal is changed, progressive pressure build-up normally appears during the first hundreds of hours of operation, because run-in particles are produced by new piston seals and deposited on the internal filter.

Therefore, after 100 or 200 hours of operation, you should clean, then reinstall, the outlet filter. This filter can be cleaned several times before having to be changed.

Figure 46
Purge Valve and Outlet Filter

CLEANING THE OUTLET FILTER

1. Remove the filter from the pump.
2. Separate the two halves of the filter casing using two 11 mm wrenches.

Figure 47
Separate the Filter Casing

3. Gently tap the top half to remove the filter cartridge (or use an air line).

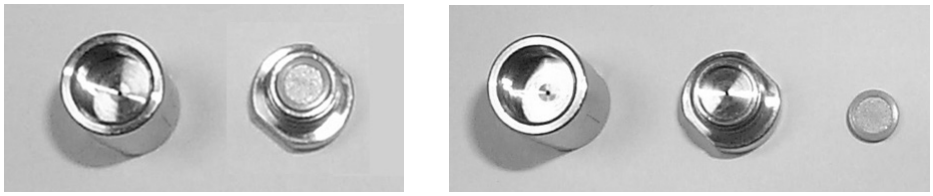


Figure 48
Filter Cartridge

4. Rinse the interior of both halves of the casing using a suitable solvent and then by using an air line to complete the cleaning process.
5. Clean the upstream face of the filter cartridge, using a jet of solvent, or fit a new filter cartridge.
6. Reinstall the filter cartridge, then reassemble the filter casing, using moderate force. When you reinstall the filter cartridge, place it in the black (downstream) half of the casing to ensure that the cartridge is properly seated before reassembling the filter casing.
7. Refit the filter to the pump and re-prime the system, checking for leaks.

Maintenance Procedures

Leak Test Procedure

This test consists of pressurizing the pump to a user selectable pressure in a closed hydraulic circuit. The outlet from the pump (filter) should be sealed with the supplied plug (part number 49041029) before running the test. Use manual control in TRILUTION LC to start the pump at a slow flow rate and allow the pump to reach a pressure of 450 bar (6526 psi) for an H1 head or 225 bar (3263 psi) for an H2 head. Stop the pump once the pressure is reached. (Alternatively, use error handling in TRILUTION LC to stop the pump once the pressure is reached as part of an application run.) If during the next five minutes the pressure decay is less than 10%, then the test is successful.

Run-In Procedure

Whenever using a new pump head or a new piston seal, it is strongly recommended to follow this run-in procedure.

1. Run the pump unloaded for 1–2 minutes at 20% of nominal flow rate with methanol or isopropanol.
2. Run the pump at maximum operating pressure for 4–5 minutes. While running, check for any leaks.
3. Repeat the first step, but for 30 minutes.

Fuse Replacement

1. Power off the instrument and disconnect the power cord.
2. Locate or order replacement fuses. (Extras were provided with the instrument.)
3. Place a small screwdriver or a fingernail under the tab on the fuse drawer to detach it from its receptacle on the rear panel. The fuse drawer will remain hinged to the instrument.
4. Replace both fuses. Use only fuses with the rated current and specified type as listed on the rear panel of the instrument.
5. Insert the fuse drawer into its receptacle on the rear panel.

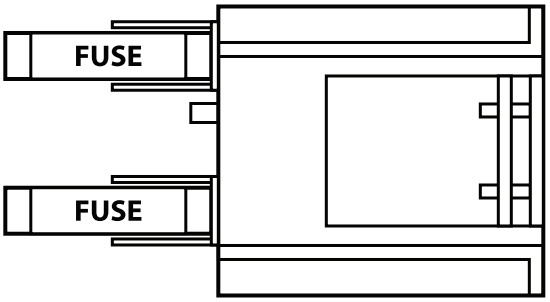


Figure 49
Fuse Replacement

Chapter 5

TROUBLESHOOTING

IN THIS CHAPTER

When troubleshooting, try to check each part of the system independently. Check the solvent bottles, the connections between the bottles and pump heads, inlet filters, outlet filters, and so on. Check each component in the circuit, even if it is new.

To receive notification of and to designate instructions for response to error states in TRILUTION LC, users must define parameters in the **Method - Error Handling** tab.

Troubleshooting

When troubleshooting, try to check each part of the system independently; try one solution at a time and proceed in a systematic way.

Electrical Problems

Problem	Possible Causes	Solutions
Pump does not operate—no POWER indicator LED	No power or fuse blown	Check fuses, plug in power cord, switch on at rear
Pump does not operate—no ON indicator LED	Pump is not operational	Press the ON/OFF key on the indicator panel

Hydraulic Problems

Problem	Possible Causes	Solutions
Air bubbles in both the inlet and the outlet tubings	Inlet tubing is loose Nut and/or ferrule damaged	Tighten the connectors Replace the nut and/or ferrule
	Inlet filter is plugged	Clean or replace the inlet filter(s)
	Refill time is too short	Increase the refill time; refer to page 29
Air bubbles in the outlet tubing only	Loose connection of outlet	Tighten connectors
Leaks from a pump head	Defective piston seal	Replace the defective seal
Abnormally low flow rate	Leaks	Check the all plumbing for leaks
	Air entering upstream from the head	Check the upstream connections
	Plugged inlet filter	Replace inlet filter
	Defective check valve	Clean or replace the check valve
	Incorrectly mounted pump head	Remount the pump head
Abnormally high pressure	Plugged outlet filter	Clean or replace outlet filter
	Column particle size too small or plugged column	Change or flush column
	Mobile phase viscosity too high	Use lower viscosity solvents or increase temperature
Baseline noise, periodic pulses	Mixer volume too small	Increase mixer volume
	Air in the hydraulics	Prime the pump, degas the solvent
	Faulty pressure module	Contact your Gilson representative

NOTE **Contact your local Gilson representative or techsupport@gilson.com for assistance resolving problems described in this chapter.**

Repair and Return Policies

Before Calling Us

Your local Gilson representative will be able to serve you more efficiently if you have the following information:

- Serial number and model number of the instruments involved
  - The serial number is located inside the door on the right side of the pump.
- Installation procedure you used
- List of concise symptoms
- List of operating procedures and conditions you were using when the problem arose
- List of other devices connected to the instrument and a description of those connections
- List of other electrical connections in the room

Warranty Repair

Units covered under warranty will be repaired and returned to you at no charge. If you have any questions about applicability, please contact your local Gilson representative.

Non-Warranty Repair

For out-of-warranty repairs, contact your local Gilson representative who will discuss service options with you and can assist in making arrangements to return the equipment, if necessary.

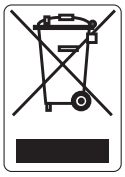
Return Procedure

Contact your local Gilson representative to obtain authorization before returning any Gilson equipment. To return a piece of equipment:

- Carefully pack the unit to prevent damage in transit. Check with your local Gilson representative regarding proper method of shipment. No responsibility is assumed by Gilson or your local Gilson representative for damage caused by improperly packaged instruments. Indicate the authorization on the carton and on the packing slip.
- Always insure for the replacement value of the unit.
- Include a description of symptoms, your name, address, phone number, and purchase order to cover repair costs, return and shipping charges, if your institution requires it.

Unit End-of-Life

When a unit reaches the end of its useful life, refer to **www.gilson.com** for directions and information on the end-of-life policy. This is in accordance with the European Union Directive on Waste Electrical and Electronic Equipment (WEEE).



Appendix A

REPLACEMENT PARTS

IN THIS CHAPTER

322 HPLC Pump

PART NUMBER	DESCRIPTION
381032211	322-H1 Pump (110 and 220V), 2-solvent, 15 mL/min, 60 MPa
381032221	322-H2 Pump (110 and 220V), 2-solvent, 30 mL/min, 30 MPa

Hydraulic

Tubing and Fittings

PART NUMBER	DESCRIPTION
380132254	322 (H1/H2) Rinse Plumbing Kit
49968522	Inlet Tubing Assembly
4957226	Inlet Filter, 20 µm, 1/4-28 (Upchurch A-225A-1)
49571426	Outlet filter assembly, 316 steel, 0.5 mm through, 2µm, 4.8 mm (Upchurch A315)
49041046	Outlet filter, 316 steel, 2 µm, 1.9 x 4.8 mm (Upchurch C402)
495018	Fitting adapter, 1/4”-28 TPI to female luer (for syringe)

TUBING AND FITTINGS CONTINUED ON PAGE 52

PART NUMBER	DESCRIPTION
49041040	Nut, 316 steel, 10-32 TPI, for 1.6 mm (1/16") tubing (Upchurch U400)
49041045	Ferrule, 316 steel, 10-32 TPI, for 1.6 mm (1/16") tubing (Upchurch U401)
380132391	Tubing Outlet, Solvent A, SS
380132103	Tubing Outlet, Solvent B, SS
380132104	Tubing Outlet, Dampener, SS
380132105	Tubing Outlet, Mixer, SS
380132106	Tubing Outlet, Filter, SS
38013233	Capillary, 316 steel, 0.13 x 1.6 x 400 mm, 5 µL, one fitting (seal replacement)
471078702	Tubing, FEP, 0.085 ID X 0.124 OD (Waste tubing)
49041015N	Ferrule, 1/8", ETFE, Natural (P-300N)
490410315	Nut, 1/4-28 ETFE (P-315)
49041029	Plug, 10-32, SS (S-1416)
490410133N	Ferrule, Tefzel®, 3/16", P-133N (Rinse Plumbing)
490410138	Nut, 5/16-24, White Delrin (P-138) (Rinse Plumbing)
38013251	Drain Nut, 5/16-24, 4.8mm Tubing, TFE (Rinse Plumbing)

Pump Heads

PART NUMBER	DESCRIPTION
38013207	H1 Pump Head
38013208	H2 Pump Head

PUMP HEAD PARTS

PART NUMBER	DESCRIPTION
38013311	Spacer, Rear, PEEK
3801320102	Chamber Body H1
3801320202	Chamber Body H2
3801320701	Rinsing Body Chamber H1
3801320801	Rinsing Body Chamber H2
38013296	Outlet Check Valve Chamber H1/H2
38013297	Inlet Check Valve Chamber H1
3801320204	Inlet Check Valve Chamber H2

Piston Seals

PART NUMBER	DESCRIPTION
38013222	Piston seal, PTFE, black, flange-type, Hastelloy C276 spring, for H1 pump head
38013224	Piston seal, PTFE, black, flange-type, Hastelloy C276 spring, for H2 pump head
38013220	Piston seal, HDPE, yellow, flange-type, Ti spring, for H1 pump head
38013223	Piston seal, HDPE, yellow, flange-type, Ti spring, for H2 pump head

Piston Assembly and Bellows

PART NUMBER	DESCRIPTION
38013226	Piston assembly with bellows, for H1 pump head
38013227	Piston assembly with bellows, for H2 pump head
38013238	Bellows, fluoroelastomer, piston rinsing compartment, for H1/H2 pump head

Check Valve Cartridges

PART NUMBER	DESCRIPTION
3650170	Check valve cartridge, inlet, for 5/10/25/H1 pump head
3650180	Check valve cartridge, outlet, for 5/10/25/H1/H2 pump head
38013225	Check valve cartridge, inlet, for H2 pump head

Electrical

PART NUMBER	DESCRIPTION
6730314007	Fuse, 3.15A

Miscellaneous (Tools, Power Cords, Cables, etc.)

PART NUMBER	DESCRIPTION
38013280	Solvent Bottle tray
38013228	Tubing clip, PP, for 3.2 mm, 1/8” for bottle tray
38013229	Tubing clip, PP, for 4.8 mm, 3/16” for bottle tray
38073202	Drip pan, PP, with drain tubing (silicone, 4 x 6 mm, 1000 mm)

MISCELLANEOUS (TOOLS, POWER CORDS, CABLES, ETC.) CONTINUED ON PAGE 54

PART NUMBER	DESCRIPTION
470223639	Tubing, silicone, 4 x 6 mm, 1 meter (drip pan tray)
7080316105	Power Cord for 110V
7080316106	Power Cord for 220V
36610101	Spanner for tubing nuts, 6.3–7.9 mm (1/4”–5/16”)
38013236	Spanner for check valve holder, 14 mm
38013237	Spanner for outlet filter, double-ended 11 and 13 mm
4320302	Allen wrench, 3 mm (rear-end, to release pump head)
4320502	Allen wrench, 5 mm (front-end, to remove pump head)
38013235	Bellows mounting tool, POM, white, piston assembly, for pump heads
36078143	GSIOC Cable, Shielded, 30”
36460058	Priming Syringe, Glass, 10 mL
38013234	Glass bottle (Piston Rinse)

Service Parts

Replacing these parts may require assistance from your technical service representative.

PART NUMBER	DESCRIPTION
38013242	Pressure module, 316 steel and PTFE, 60 MPa, 1.8–8.5 mL
38013278	Purge valve, 316 steel and PCTFE, 8 µL
360650	AVDM Mixer with Motor Assembly

Appendix B

COLUMN HOLDER

IN THIS CHAPTER

Installation

The column holder attaches to the left side of the pump. Three pairs of column support, fitted with clips for different diameter columns, are provided in the kit.

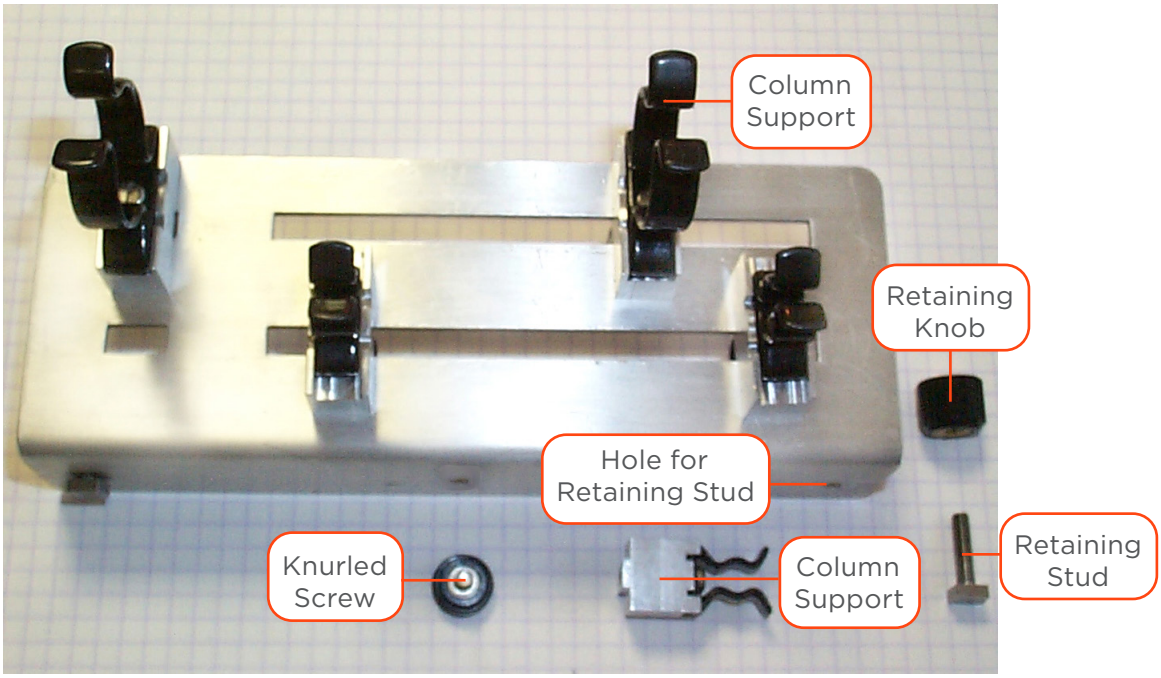


Figure 50
Column Holder

Holder Installation

1. Loosely fit the retaining stud.
2. Slide the studs into the tops of the retaining slots at the side of the pump.
3. When the holder is correctly positioned, fully tighten the retaining knobs.

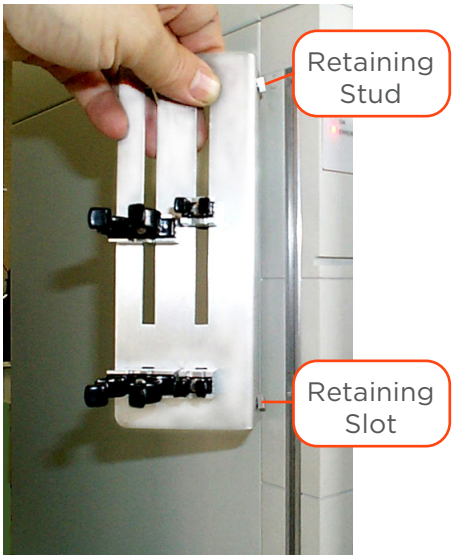


Figure 51
Holder Installation

Support Installation

1. Push one of a pair of column supports into either of the slots.
2. Fix the column support in position using a knurled screw.
3. Repeat for the second column support but don't fully tighten the screw.
4. Slide the second column support along the long slot to match the length of the column.
5. Fully tighten the screws.

Figure 52
Support Installation

Part Numbers

PART NUMBER	DESCRIPTION
38013203	Column holder, equipped for 2 to 20 mm ID column
380132661	Column holder clips, 1/4″ (2 mm), 2/pk
380132662	Column holder clips, 1/2″ (10 mm), 2/pk
380132663	Column holder clips, 1″ (20 mm), 2/pk

Appendix C

INJECTOR

IN THIS CHAPTER

Injection Valve Holder

The injection valve holder has two pairs of holes, one pair is for mounting the valve in the vertical position and the other is for mounting the valve in the horizontal position.

Holder Installation

1. Loosely fit the retaining studs to either pair of holes.
2. Slide the feet into the top of the retaining slot at the side of the pump.
3. When the holder is securely positioned, fully tighten the retaining feet knobs.

Figure 53
Holder Installation

Valve Installation

1. Secure the valve body to the holder using two screws.
2. Fit the valve handle, as described in the documentation supplied by the valve manufacturer.

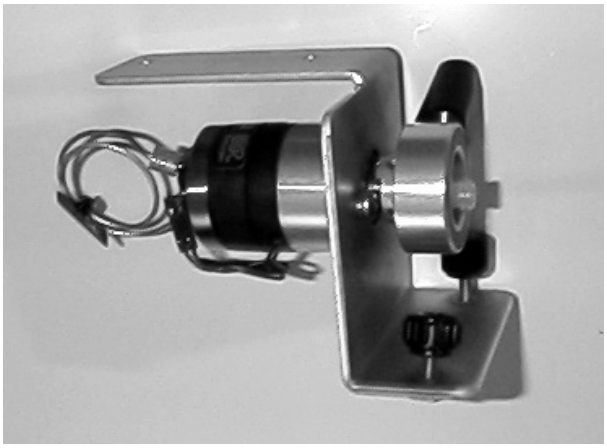


Figure 54
Valve Installation

Connection to Injector

For flow rates lower than 10 mL/min, use the 0.25 x 1.6 x 550 mm tubing (part number 49931559).

For flow rates higher than 10 mL/min, use the 0.5 x 1.6 x 500 mm tubing (part number 49933509).

Part Numbers

PART NUMBER	DESCRIPTION
38013205	Valve holder with manual Rheodyne 7725i injection valve
38013206	Valve holder without valve
49931559	Tubing, 316 steel, 0.25 x 1.6 x 550 mm, 27 µL (to injector, <10 mL/min)
49933509	Tubing, 316 steel, 0.5 x 1.6 x 500 mm, 98 µL (to injector, >10 mL/min)

Appendix D

REFERENCE INFORMATION

IN THIS CHAPTER

Liquid Contact Materials

The information provided in the following table is accurate to the best of our knowledge and belief, but it is intended for general information only (classified by alphabetical order).

Liquid Contact Materials

Material	Description
ETFE	Ethyltrifluoroethylene (ETFE) is the generic name for the material such as Tefzel®. A fluoropolymer used for sealing surfaces, it is resistant to most chemical attack; however, some chlorinated chemicals will cause a physical swelling of ETFE tubing.
FEP	Fluorinated ethylene propylene (FEP) is a member of the fluorocarbon family with similar chemical properties as PTFE. It is generally more rigid than PTFE, with somewhat increased tensile strength. It is typically more transparent than PTFE, slightly less porous, and less permeable to oxygen. FEP is not as subject to compressive creep at room temperature as PTFE, and because of its slightly higher coefficient of friction is easier to retain in a compression fitting.
HDPE	HDPE (high density polyethylene) piston seals are yellow and provide longer service with water, aqueous solutions, alcohols and acetonitrile.
PCTFE	This material is a homopolymer of chlorotrifluoroethylene which has many of the properties similar to other fluoropolymers such as PTFE or FEP, but is mechanically superior in rigidity (does not deform easily), and has very low gas permeability. Its dimensional stability makes it attractive for use as a component of a structural part where the high temperature and chemical resistance of fluoropolymers is required. PCTFE shows high compressive strength and low deformation under load.
PEEK™	PEEK (Polyetheretherketone) is not affected by halide salts, high strength buffers, or other aggressive mobile phases that corrode stainless steel. The polymer surface will not leach metal ions into the eluent or extract metal-sensitive components from the sample.

LIQUID CONTACT MATERIALS CONTINUED ON PAGE 60

Liquid Contact Materials

Material	Description
PTFE	Polytetrafluoroethylene is the generic name for the class of materials such as Teflon®. It offers superior chemical resistance but is limited in pressure and temperature capabilities. Because it's so easy to handle, it is often used in low pressure situations where stainless steel might cause adsorption. PTFE tubing is relatively porous, and compounds of low molecular weight can diffuse through the tubing wall. Use the black PTFE piston seals with organic solvents.
Ruby / Sapphire	Synthetic rubies and sapphires are single-crystal aluminum oxides, practically pure for the sapphire (+99,99% Al_2O_3). The color of the ruby is produced by adding a few ppm (parts per million) of chromium oxide (CrO_3). Synthetic rubies and sapphires have a hexagonal-rhombic crystal structure, density of 3.99 g/cm^3 and a water absorption coefficient of 0%. The principal properties of synthetic rubies and sapphires include a hardness and high mechanical strength, excellent resistance to wear, very low friction coefficient, chemically inert, good thermal conductivity, ideal electrical insulation.
Stainless Steel, Type 316L	Type 316L is an extra low carbon alloy that offer better corrosion resistance adjacent to brazes. This alloy contains a maximum of only 0.03% carbon. This amount of carbon is small enough to eliminate harmful carbon precipitation adjacent to brazes during the brazing operation. This extra low carbon grade is only recommended for equipment made for service below the lower sensitizing temperature of 800 deg. F, especially when corrosive conditions are severe. It is not recommended for use at high temperature. This grade can be highly polished with no surface blemishes.

TRADEMARK DESCRIPTION REFERENCES

PTFE, PEEK, FEP, ETFE and Titanium descriptions provided by Valco Instruments Co. Inc. (www.vici.com)

PCTFE description provided by Fluorotherm (www.fluorotherm.com)

Stainless Steel, Type 316L description provided by New England Small Tube Corporation (www.nesmalltube.com)

Ruby/Sapphire description provided by Ceramaret SA (www.ceramaret.ch)

Solvent Miscibility

Miscibility means that solvents should mix with each other in all proportions. Solvent miscibility is important both during elution and when switching from one solvent to another.

Refer to the table below when selecting solvents. For some solvents, lower toxicity alternatives are indicated [(1), (2), (3)], as follows: